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NOTES ON GEOGRAPHIC DISTRIBUTION

Distribution of *Strobilops aeneus* Pilsbry, 1926, in Canada, with two new Ontario records (Mollusca: Gastropoda: Strobilopsidae)

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ABSTRACT: The geographic distribution of *Strobilops aeneus* Pilsbry, 1926, a rare species in Canada, is reviewed and all known records are mapped. Two recent records, the only ones since 1941, are reported from the province of Ontario. One of these records represents a small range extension *ca*. 85 km north of the closest previous site. Specimens identified as *S. aeneus* from Ontario, New Brunswick, and Nova Scotia were re-examined and found to be another species.

There are just over 200 species of land snails and slugs in Canada, and while the majority of species are broad Nearctic or Holarctic ranges, others are range-edge species that occur in Canada just north of the border with the United States (Forsyth 2013). Southern Ontario has special malacological interest because of a concentration of range-edge species that in Canada only occur here and have restricted ranges (Pilsbry 1940, 1946, 1948; Oughton 1948). This region, one of the most biodiverse areas in Canada (Warman *et al.* 2004; Ontario Biodiversity Council 2010), is at the heart of the Mixedwood Plains ecozone (Figure 1), which borders the upper St. Lawrence River and easternmost Great Lakes (Ecological Stratification Working Group 1995). However, the Mixedwood Plains is almost completely dominated by human land uses and habitat loss has been severe, with 88% of the ecozone's area modified by intensive agriculture, urbanization and other uses (Kerr and Deguise 2004). Since European colonization began, the majority of natural forest cover in much of this region has been lost (Butt *et al.* 2005). Natural forests exist nowadays as small, isolated patches, which are under ongoing habitat loss and degradation by invasive species (Forsyth 2013).

Among Canadian provinces and territories, Ontario is relatively well known for terrestrial molluscs. The historically most important person associated with the Ontario malacofauna is John Oughton, who in 1948 published the first and only comprehensive biogeographic study of terrestrial snails and slugs of the province (Oughton 1948). One of a few species that he newly recorded is a small, rare land snail, *Strobilops aeneus* Pilsbry, 1926.

Strobilops aeneus belongs to the orthurethran family Strobilopsidae (Pilsbry 1927, 1948). It is one of five species in its family and genus in North America (Pilsbry 1948; Turgeon *et al.* 1998) and one of three species in Canada (La Rocque 1953). The other species in Canada are *S. affinis* Pilsbry, 1893, and *S. labyrinthicus* (Say, 1817). Elsewhere in Canada, *S. aeneus* was reported by MacMillan (1954) from Cape Breton Island, Nova Scotia, and by Lauriol *et al.* (2003) in a palaeoecological study of Holocene cave infill on the Eardley Escarpment, Gatineau Park, in southwestern Quebec. There are no published records of the species from New Brunswick, but the New Brunswick Museum had one record identified as this species.

Pilsbry (1927, 1948) provided descriptions, figures, and a key to *Strobilops* species. The genus, as it occurs in Canada, is recognized by the combination of the following characters. Shells are small (diameter, 2.3–2.9 mm), conical or dome-shaped, and with riblets on at least the upper surface of the whorls. Inside the last whorl, there are various barriers in the form of parietal, basal and (in some) palatal spiral lamellae. Among Canadian pupilloids, the presence of these barriers at all post-embryonic stages of growth is noteworthy. Full-grown shells are marked by a final expansion and thickening of the apertural lip (Pilsbry 1927, 1948; Schileyko 1998).

Among the Canadian species of *Strobilops, S. aeneus* is distinguished from the two other species by its lower spire, with nearly straight sides, three or four basal and no palatal lamellae rather than altogether five or more internal basal and parietal lamellae, the flattened base with slightly broader umbilicus, less deeply rounded aperture, and compressed last whorl (Table 1; Figures 2–4). The width of the umbilicus was said to differ between species (Pilsbry 1927, 1948) but this was found to be subtle, difficult to measure, and possibly uninformative when compared to the other, more easily observed characters.

There has been confusion between *S. aeneus* and its congeners in collections and the literature. This stems from the fact that (at least some) adult shells of the other species are obtusely angular at the periphery but also more strongly angular when immature. Without looking at all the characters separating these species, it is possible to misidentify other *Strobilops* species as *S. aeneus.* Among the three Canadian *Strobilops* species, *S. aeneus* is the most distinctive; *S. labyrinthicus* and *S. affinis* are more difficult to distinguish from each other.

This paper was initiated because of the chance find of this species in eastern Ontario by Forsyth. This was during a general reconnaissance-type survey for terrestrial snails in the Ottawa area. Twenty sites were surveyed over five days from 11–16 September 2012. Time spent at each site was usually brief but the intent was to search as many sites and habitats as possible. Sites varied from urban to rural and included alvars, natural forests, and a variety of disturbed habitats. Snails were searched for by hand-searching appropriate microhabitats. A hand-held Global Positioning System receiver (Garmin eTrex Vista HC) was used to find geopositional data; the datum used was WGS84.

For over 21 years, one of us (Oldham) has made general surveys all over Ontario for terrestrial molluscs. This has included a variety of sampling methods including hand searching as well as drift and litter sampling. Within the roughly 1,500 samples taken over this period, *Strobilops aeneus* were found only once. The Ontario Ministry of Natural Resources provided a research permit to Oldham to collect in Wheatley and other provincial parks.

Several collections were consulted, including the Canadian Museum of Nature (Gatineau, Quebec; CMN), New Brunswick Museum (Saint John, New Brunswick; NBM), Royal Ontario Museum (Toronto, Ontario; ROM), Nova Scotia Museum (Halifax, Nova Scotia; NSM), and Carnegie Museum of Natural History (Pittsburgh, Pennsylvania; CMNH). The CMN and NBM were visited in person. Correspondences with collections' personnel and

Table 1. Characteristics of *Strobilops* spp. in Canada adapted from Pilsbry (1927, 1948).

Species	*Strobilops aeneus* (Figure 2)	*Strobilops labyrinthicus* (Figure 3)	*Strobilops affinis* (Figure 4)
Basal/palatal lamellae	3 or 4 basal lamellae; no palatal lamella	Usually 5 or 6 basal and palatal folds	Usually about 8 basal and palatal folds
Spire	Lower, conical, sides slightly convex	Domed; sides convex	Domed; sides convex
Periphery of last whorl (adults)	Prominently angular due to compressed last whorl	Rounded or obtusely subangular but last whorl not compressed	Rounded or obtusely subangular but last whorl not compressed
Base/aperture/ last whorl of adults	Flattened; aperture not downwardly rounded; last whorl narrow (in apertural view)	Rounded; aperture downwardly rounded; last whorl deeper (in apertural view)	Rounded; aperture downwardly rounded; last whorl deeper (in apertural view)
Diameter	2.4–2.7 mm (largest Ontario specimen 2.9 mm)	2.3–2.5 mm	2.75–2.9 mm

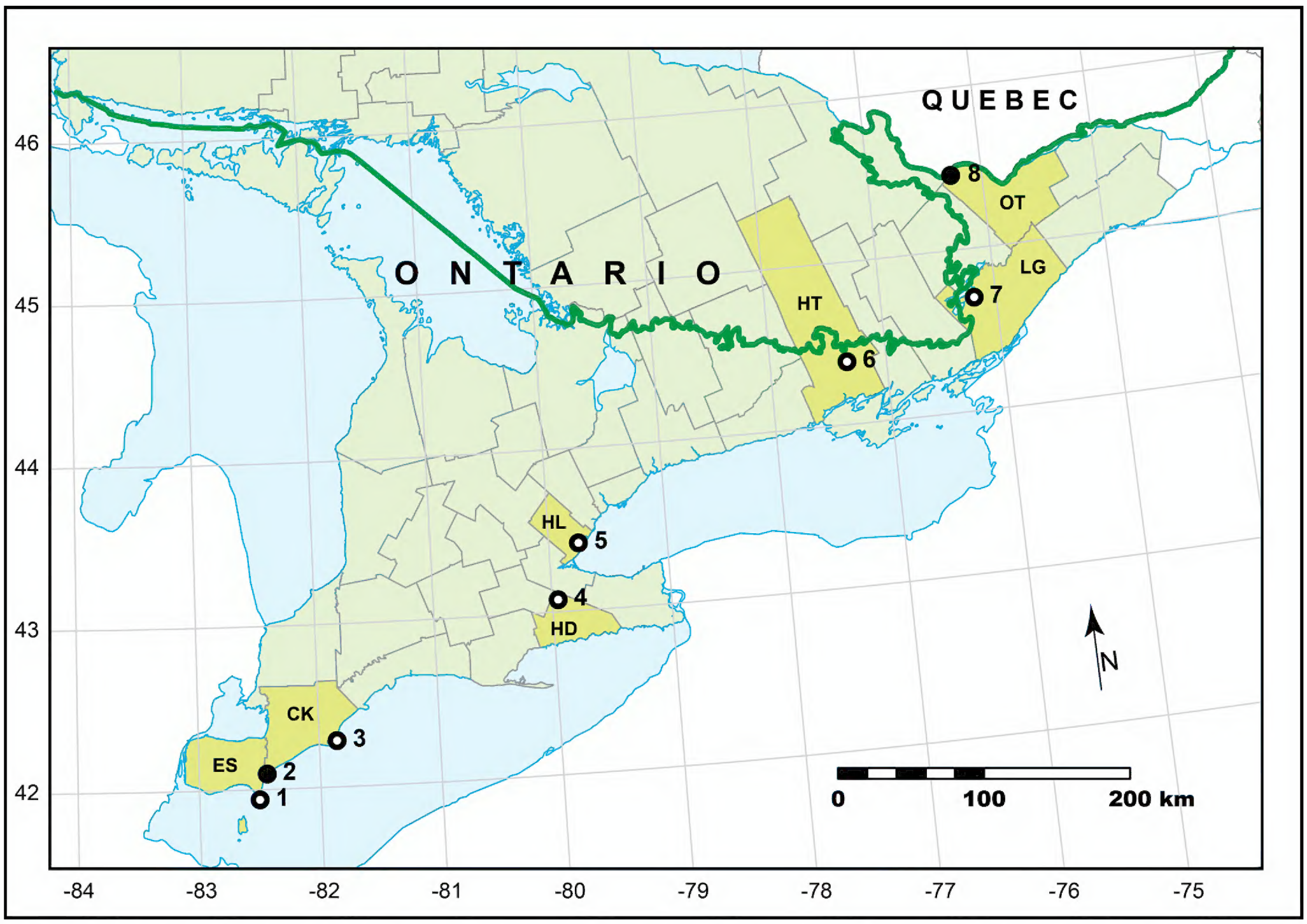

Figure 1. Southern Ontario showing historical records (open circles) and new records (filled circles) of *Strobilops aeneus*. Numbers correspond to localities in Table 1. The green line represents the northern limit of the Mixedwood Plains ecozone. Abbreviations of counties or regions: CK, Chatham-Kent Regional Municipality; ES, Essex County; HL, Halton Regional Municipality; HD, Haldimand County; HT, Hastings County; LG, Leeds and Grenville United Counties; OT, Ottawa.

loans or photographs of specimens were arranged from the other institutions.

Because the historical records lack geopositional data, for the purposes of mapping, topographic maps were used to find approximate latitude and longitude.

Oughton's dot map of *Strobilops aeneus* shows six occurrences (three "good" records and three "doubtful") scattered along the Great Lakes from Essex County in the west to Leeds County in the east (Oughton 1948). The majority of Oughton's collections ultimately ended up divided between the UMMZ (University of Michigan Museum of Zoology, Ann Arbor, Michigan) and ROM, and it is with difficultly that dots on his map can be linked with individual specimen lots. However, six specimen lots of *S. aeneus* were found in these collections (Table 2). Some of this material was found in samples of stream drift, which probably accounts for its poor condition, either broken or immature, or both. One of these old records containing a mixture of species (ROMIZ M6445) was apparently overlooked by Oughton. It consists of a single, broken shell of *S. aeneus* mixed in with *S. affinis.* Of the six old records, one (UMMZ 180493) is doubtfully *S. aeneus.* The original label, presumably by Oughton, also suggests doubt.

During study of ROM specimens, it was found that specimens of *Strobilops affinis* were subsequently re-identified as *S. aeneus* by another researcher. These are not *S. aeneus* but rather *S. affinis* as originally identified by Oughton.

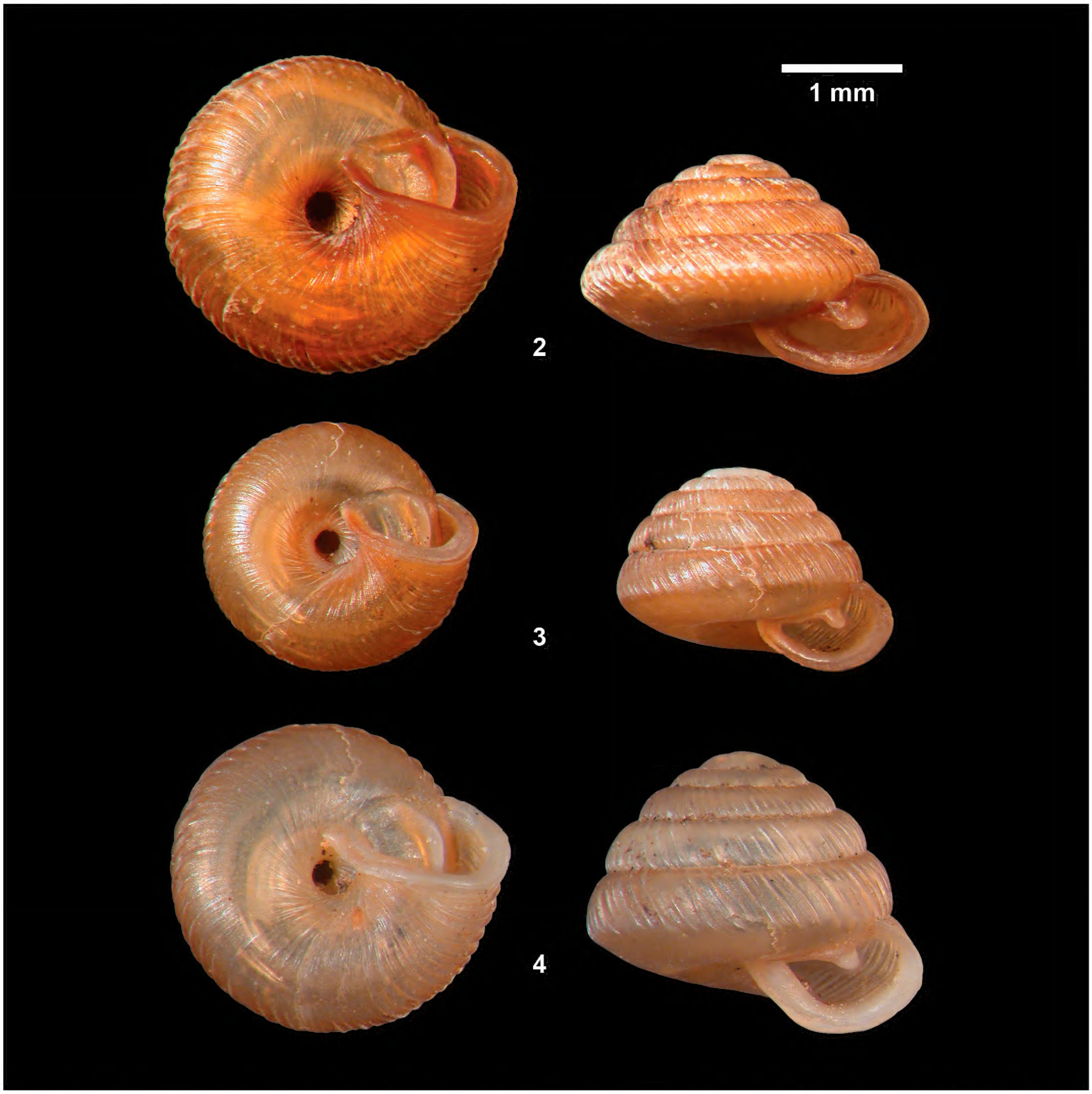

Figure 2–4. *Strobilops species* in Canada. 2, *S. aeneus*, Morris Island Conservation Area, Ottawa, Ontario, Canada (Table 2, site 8), *leg*. R. G. Forsyth, 11 September 2012 (45°27′32.9″ N, 076°16′17.4″ W), diameter 2.9 mm (NBM 009023). 3, *S. labyrinthicus*, Pink Road Alvar, Gatineau, Quebec, Canada, *leg*. R. G. Forsyth, 20 September 2012 (45°26′30″ N, 075°52′21″ W), diameter 2.3 mm (Forsyth collection 12.136.6245). 4, *S. affinis*, 0.5 mile east of Nancy Lake, King Township, York County, Ontario, Canada, *leg*. John Oughton, 20 May 1940 (coordinates of location not recorded and not traced), diameter 2.8 mm (ROM Invertebrate Zoology M6446).

Table 2. Historical and new records of *Strobilops aeneus* in Ontario, Canada. Records are ordered west to east. Locality numbers correspond to those in Figure 1. Specimens are classified as "fresh" if they appear to have been recently dead or alive at the time of collection; *i.e.*, they are not worn, broken, or filled with sediment as is normal for specimens collected from drift samples.

#	Collection, number	Locality	County or region [current name if different]	Geoposition [subsequently derived, approximate]	Collector	Date Collected	Number of Specimens	Comments
1	UMMZ 180492	E side of Point Pelee	Essex County	[41°56′18″ N, 082°30′21″ W]	John Oughton	16 May 1937	1	Mature, spire broken away; from drift
2	NBM 009022	Wheatley Provincial Park	Chatham-Kent Regional Municipality	42°05′43.7″ N, 082°26′24.4″ W	M. J. Oldham	20 May 2006	6	1 mature; 5 immature; live-collected
3	ROMIZ M6449	Rondeau [Provincial] Park	Kent County [Chatham-Kent Regional Municipality]	[42°17′04″ N, 081°51′12″ W]	John Oughton	15 May 1937	1	Immature, appears fresh
4	UMMZ 180493	Caledonia	Haldimand County	[43°04′29″ N, 079°57′05″ W]	H. S. Troyer	12 Apr. 1941	1	Immature; from drift; "prob" on original label; another species?
5	UMMZ 180494	Bronte Creek, 2.5 mi. N of mouth	Halton County [Halton Regional Municipality]	[43°24′55″ N, 079°44′56″ W]	John Oughton	Not recorded	1	Immature; from drift
6	ROMIZ M6445 (in part)	½ mi. SE of Thomasburg	Hastings County	[44°23′13″ N, 077°20′21″ W]	H. B. Herrington	6 Apr. 1938	1	Mature, spire broken away (2 additional specimens are not this species)
7	ROMIZ M6447	Near Portland	Leeds County [Leeds and Grenville United Counties]	[44°41′52″ N, 076°11′22″ W]	H. B. Herrington	27 Oct. 1940	1	Mature, appears fresh
8	NBM 009023	Morris Island Conservation Area	Ottawa	45°27′32.9″ N, 076°16′17.4″ W	R. G. Forsyth	11 Sep. 2012	1	Mature, live-collected

On 20 May 2006, six specimens of *Strobilops aeneus* were collected in Wheatley Provincial Park, Chatham-Kent Regional Municipality, Ontario, by Oldham (Table 2). Only one of these specimens is full-grown. Aside from the size (diameter, 2.4 mm × height, 1.5 mm), straight sides to the spire, and last whorl with a pronounced though blunt peripheral angle caused by the compression of the large whorl, this shell has three basal lamellae and no palatal lamellae. The immature examples show enough of the characters needed to identify them as *S. aeneus.* These snails were from Sugar Maple (*Acer saccharum* Marshall) woods. Other terrestrial snails found in the general area included *Anguispira alternata* (Say, 1817), *Cochlicopa lubrica* (Müller, 1774), *Glyphyalinia indentata* (Say, 1823), and the rare *Stenotrema barbatum* (Clapp, 1904).

On 11 September 2012, Forsyth collected one specimen of *Strobilops aeneus* at Morris Island Conservation Area, in the Ottawa Region, along the Ottawa River, Ontario (Table 2; Figure 2). The identification of this specimen was confirmed by Dr. T.A. Pearce, Carnegie Museum of Natural History. This specimen is 2.9 mm (diameter) by 1.75 mm (height). It also has straight sides to the spire, and the pronounced though blunt peripheral angle caused by the compressed form of the last whorl. Four basal lamellae are present (not well shown in Figure 3) and no parietal lamellae. This specimen is slightly (5%) larger than the largest of three measured shells (and the holotype; 2.75 mm) recorded by Pilsbry (1948). The snail was found alive on dead wood (a branch) on deep, rich leaf litter in a mixedwood forest. Deciduous trees were dominant. In the immediate vicinity were found shells of *Neohelix albolabris* (Say, 1817), and within *ca.* 5 m along the disturbed wood edge were found *Helicodiscus parallelus* (Say, 1817) and *Vallonia costata* (Müller, 1774).

Specimens supporting these new records have been deposited in the New Brunswick Museum (Wheatley Provincial Park, NBM 009022, 6 specimens in alcohol; Morris Island Conservation Area, NBM 009023, 1 dry specimen).

The New Brunswick Museum had one lot identified as *Strobilops aeneus,* but examination of this specimen found that it is an immature *S. labyrinthicus.* It was collected at Lower Cambridge Narrows, Queens County, New Brunswick (NBM 008762, 1 specimen, dry shell). The lip is not thick, and the last whorl has a slightly angular periphery, less pronounced than in *S. aeneus* but which is typical for *S. labyrinthicus.*

Lauriol *et al.* (2003) reported six specimens as "*Strobilops* cf. *aenea* [*sic*]" from infill material retrieved from a Quebec cave. The whereabouts of these specimens is unknown, and so they could not be re-examined. The mollusc identifications were made by the late F. Wayne Grimm and Isabelle Picard. Picard, who has extensively surveyed for this species in Quebec, has no other records for *S. aeneus* from the province; she was not sure of the identifications at the time, perhaps because the specimens were in poor condition or juvenile (I. Picard personal communication). La Rocque (1953, 1962) did not include it from Quebec in his catalogue and checklist of species.

MacMillan (1954) reported both *Strobilops aeneus* and *S. labyrinthicus* from Nova Scotia for the first time. The Carnegie Museum of Natural History has in its

holdings a single specimen of each species, as determined by MacMillan (T.A. Pearce personal communication). MacMillan collected both specimens on 14–18 August 1950 along Baddeck Bay Brook, Cape Breton Island, Victoria County, Nova Scotia, Canada. The specimen identified as *S. aeneus* has the spire largely broken away (CMNH 82907); that identified as *S. labyrinthicus* is in better condition. Photographs of these specimens provided by T.A. Pearce show that both specimens are likely *S. labyrinthicus*. Although MacMillan's record was subsequently accepted in the literature (Davis 1985, 1992), no additional records from the province are known, including in the collection of the Nova Scotia Museum.

With all known records of *Strobilops aeneus* from Nova Scotia and New Brunswick found to be incorrect, and uncertainty about the only known Quebec record, this species is only known with assurance in Canada from Ontario. The two recent newly reported finds are the first in Ontario since 1941. The Morris Island Conservation Area record represents a small range extension of approximately 85 km north of the closest previously known site near Portland, Ontario. There remains some question about the identity of specimens retrieved from infill of a Quebec cave and about the presence of the species in Quebec because no other records are known. However, the close proximity of the Morris Island Conservation Area to Quebec—it lays just across the Ottawa River—makes it likely that *S. aeneus* also occurs there.

With the possible exception of the Quebec cave record, *Strobilops aeneus* has gone unnoticed for 65 years despite more recent fieldwork by F. Wayne Grimm, Michael J. Oldham, Frederick W. Schueler, Robert Forsyth, and Isabelle Picard in Ontario and Quebec. Although a relatively small snail perhaps overlooked because of its size, *S. aeneus* may be truly rare in Canada, as Oughton (1948) thought.

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